



# Snowmass LOIs from Fermilab Scientists and Engineers

Fermilab PAC July 2020 Meeting

July 2, 2020

Bo Jayatilaka and Brendan Kiburg for the Scientist Advisory Council

## PAC Charge

We ask the committee to review the scope of the LOIs proposed by Fermilab Scientists and Engineers.

# SAC Working Groups

## *Frontier Physics Groups:*

**Precision** - Chris Polly, Ron Ray

**Energy** - Pushpa Bhat, Anadi Canepa, Paddy Fox, Sergo Jindariani, Sergei Nagaitsev

**Cosmic** - Brad Benson, Gordan Krnjaic, Albert Stebbins, Alex Drlica-Wagner

**Neutrinos** - Minerba Betancourt, Zarko Pavlovic, Joseph Zennamo, Peter Shanahan

## *Technology Groups:*

**Accelerator Science** - Jonathan Jarvis, Nikolay Solyak, Sasha Valishev, Sam Posen, Tiziana Spina

**Quantum Science** - Roni Harnik, Panagiotis Spentzouris

**Detectors** - Juan Estrada, Angela Fava, Zoltan Gece, Vadim Rusu

**Computational Science** - Chris Jones, Adam Lyon

Good alignment with 2021  
Snowmass Frontiers

**Rare Process/Precision**

**Energy**

**Cosmic**

**Neutrino**

*Theory*

*Underground Facilities*

**Accelerator Science/Tech**

**Instrumentation**

**Computing**

*Community Engagement*

# Working Group Charge

Working groups established in 2019 prior to Fermilab Retreat

- I. Determine interest levels of experiments/technologies
- II. Identify resources (including expertise) needed for high-priority items
- III. **Fermilab input to the Community**

For high interest items identified in Parts I & II, discuss what is needed to engage the larger community. Consider what process or metrics will be used to determine whether these are the best projects for the future and/or to decide between different high interest options. How can we enable Fermilab to take part in these efforts?

*As examples, consider setting up monthly meetings, organizing working groups, defining specific studies, writing a white paper, taking part in community planning efforts **such as Snowmass, etc.***

# Since January PAC Meeting

- Since call for Snowmass LOIs, asked Working Group Leaders to tabulate known LOI plans
  - Asked to identify topic, contact author(s), community participation
  - Identify considerable non-scientific effort needed for whitepaper plans
  - Identify significant programmatic areas **without white paper plans**
- Call for Snowmass LOIs and informing Fermilab scientific community
  - Working group meetings to discuss plans and progress
  - Updates from the SAC at all-scientist meetings
    - Detailed overview of Snowmass process from Joel Butler (DPF Vice-Chair)
- Working Group Leaders presented known LOIs in progress last month
  - Summarized on next few slides
  - Primarily efforts **led** by Fermilab scientists
    - **Other LOIs will have Fermilab scientists as co-authors** (a number already uploaded)

# Neutrino Frontier

- LOI plans
  - Tau Neutrino Appearance in Accelerator-Based Neutrino Beams (Laura Fields)
  - An H<sub>2</sub>+D<sub>2</sub> Detector in the LBNF Neutrino Beam (Laura Fields, Tom Junk, Alan Bross)
  - Using the DUNE Opportunity Module as a  $0\nu\beta\beta$  Decay Platform (Joseph Zennaro)
  - Searches for new light weakly interacting particles using proton beam dumps at FNAL (Matt Toups)
- Planned meetings
  - Follow-up to recent “Physics Opportunities at a Booster Replacement” likely in July, date TBD.
- Previously discussed topics not being developed
  - Fermilab facilities (e.g. testbeams, beamlines, underground facilities)
  - DUNE 4th module detector R&D

# Energy Frontier

- Recent WG Activities focused on Snowmass:
  - Presentation by Snowmass EF conveners and discussion, May 13, 2020; hosted as an LPC event
  - EF WG meeting on May 19 to discuss LOIs
    - Next meeting planned June/July; subgroups meet independently
- Planned LOIs (contact author)
  - Dark matter searches at future colliders (Jayatilaka)
  - Vector boson scattering (Berryhill)
  - Higgs coupling/mass/width (Bhat/Jindariani)
  - Strong SUSY (Hirschauer)
  - Higgsinos (Canepa)
- Other potential LOIs
  - Future high-energy accelerator options for Fermilab (Bhat)
  - Conductors for High Field Magnets for Future Accelerators (Spina)

# Rare and Precision Measurements

- Recent WG Activities focused on Snowmass:
  - Participation in Booster Upgrade Workshop May 18,19
- Snowmass Letters of Interest (contact author)
  - Mu2e-II prioritized critical R&D; Committee formed to prepare Snowmass contributions (Porter)
  - Broad CLFV program (Bernstein)
  - Redtop has a staged, highly-developed eta factory proposal (Gatto)
  - LDMX received Dark Matter Initiatives funding (Tran)
  - M<sup>3</sup> Muon Missing Momentum experiment (Krnjaic, Tran)
  - Darkquest - Pursuing staged approach with parasitic measurement in E1039
- Other potential LOIs
  - Examining potential for lepton universality tests (e.g. PIENU) at PIP-III (Polly)
  - Participation in storage ring EDMs (deuteron, proton, muon)
  - $N \rightarrow N\bar{b}$  oscillations

# Cosmic Frontier

## Identified LOI topics

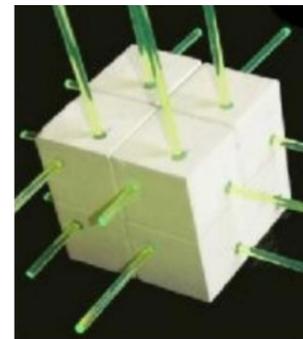
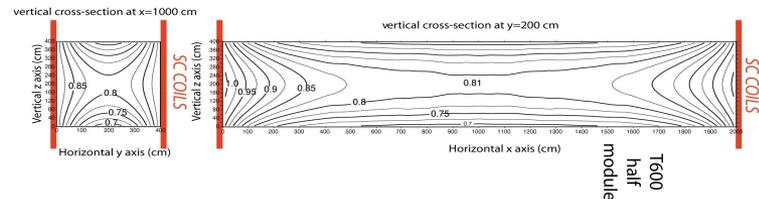
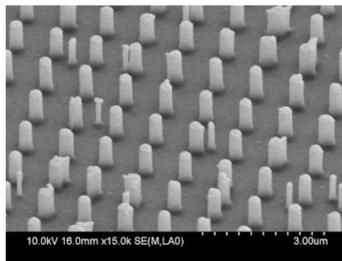
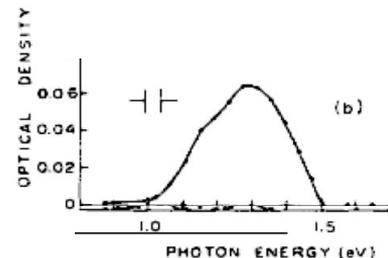
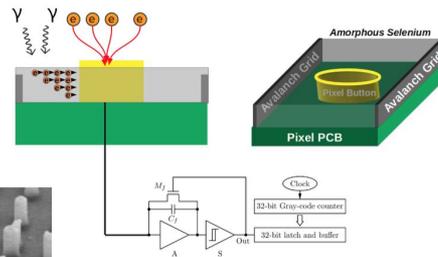
- Axion dark matter (Chou, Rybka)
- AI/Cosmology (Nord)
- Joint cosmology analysis of late-time cosmic structure formation probes (Zhang)
- 21cm cosmology opportunities in the next decade (Stebbins, Slosar)
- Astrophysical probes of dark matter (Drlica-Wagner)
- Low-mass dark matter direct detection (Kurinsky, Hsy, Estrada, Tiffenberg)
- Cosmic microwave background (Benson, Anderson)
- Dark energy (to be multiple sub-topics)
- Galactic center excess (McDermott, Hooper, Fox)

# Computational Science

- FNAL-associated experiments' white papers
  - US CMS
  - DUNE
- Collaborating with other organizations
  - HEP Software Foundation (HSF)
    - Contributing intensity frontier content to existing white papers
- Cross DOE/NSF collaboration
  - HEP Center for Computing Excellence (HEP-CCE)
  - Institute for Research and Innovation in Software for HEP (IRIS-HEP)
  - Built upon the community white paper from 2017
    - “A Roadmap for HEP Software and Computing R&D for the 2020s”
- Other potential white papers
  - Soliciting input from Fermilab scientific computing community

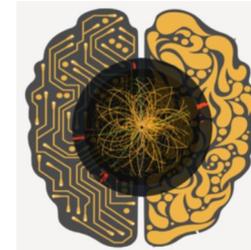
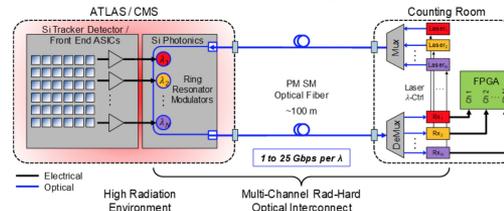
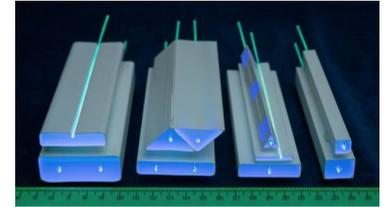
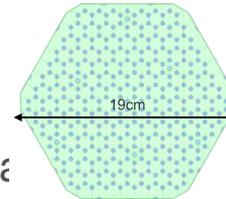
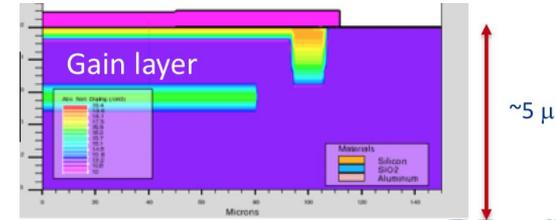
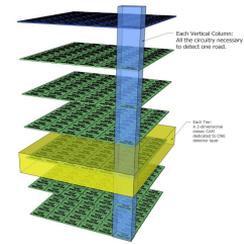
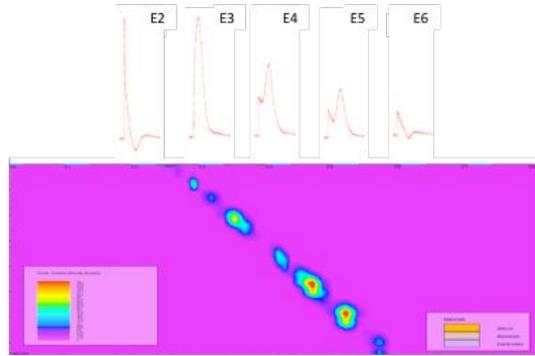
# Detectors: Neutrino Frontier

- Light&charge pixel readout
  - Elena Gramellini, Jonathan Asadi
- NIR in Lar
  - Carlos Escobar
- Doping in Lar
  - Carlos Escobar
- Stable avalanche gain in Lar
  - Angela Fava, David Caratelli
- Magnetizing Lar
  - Claudio Montanari
- HV in Lar
  - Sarah Lockwitz
- Power over fiber
  - Flavio Cavanna, William Pellico
- Injection molded scintillator for future high granularity experiments – Dune 3DST
  - James Freeman



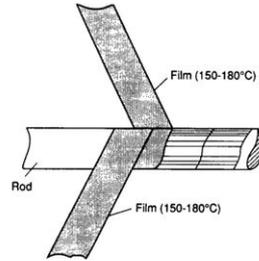
# Detectors: Energy Frontier

- 4D-tracker R&D with 3DIC
  - Ted Liu
- Induced current detectors
  - Ron Lipton
- AC buried layer LGADs
  - Artur Apresyan, Ron Lipton
- Silicon Sensors for 5D Calorimeters
  - Zoltan Gecse
- Scintillator extrusion for mega-experiments – Mathusla
  - James Freeman
- Intelligent on/off-detector realtime electronics using ML
  - Nhan Tran, Sergo Jindariani
- High-speed links
  - Alan Prosser

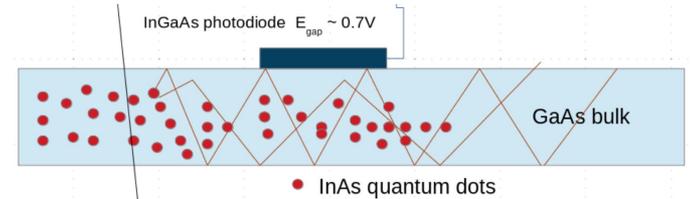
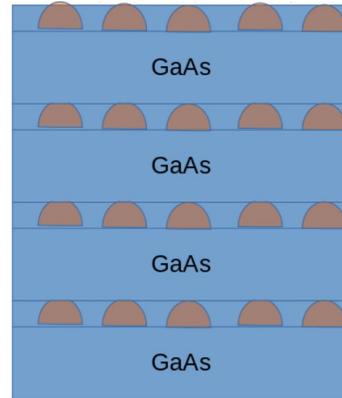
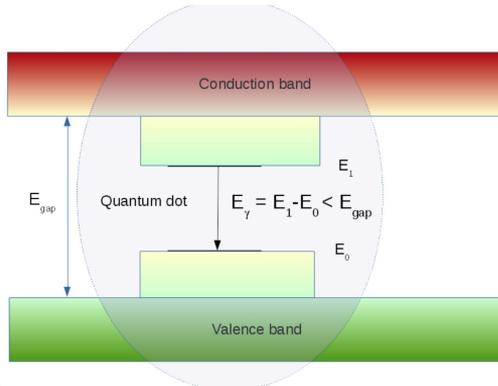


# Detectors: Precision Frontier

- Straw tracker R&D
  - Brendan Casey

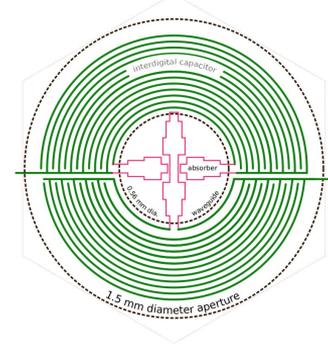
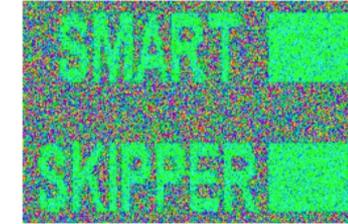
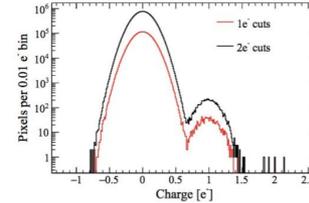
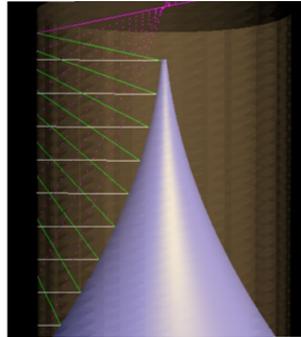
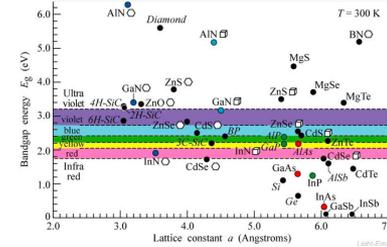
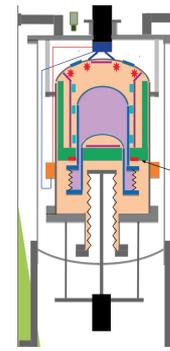
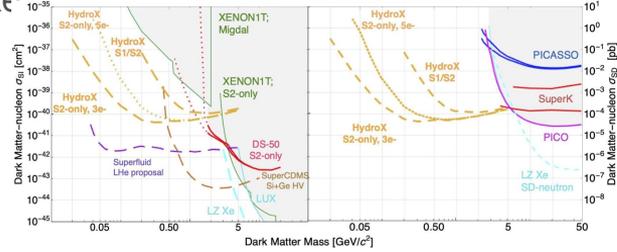


- Quantum dot scintillators
  - Pavel Murat



# Detectors: Cosmic Frontier

- HydroX: hydrogen dissolved in Liquid Xe
  - Eric Dahl
- SBC: superheated scintillating argon
  - Eric Dahl
- New materials for particle detection
  - Noah Kurinsky
- Silicon detectors with non destructive readout for dark matter and neutrinos
  - Guillermo Fernandez Moroni
- Skipper-CCDs optical and near IR
  - Alex Drlica-Wagner
- Axions instrumentation
  - Rakshya Khatiwada
- MKIDs for CMB
  - Bradford Benson
- MKIDs for optical and near IR astronomy
  - Juan Estrada
- Readout and control of superconducting detectors
  - Gustavo Cancelo



# Accelerator Science (1)

- SC Magnet LOIs
  - Conductors for future accelerators (Spina)
  - High-field magnets for future colliders: LTS and HTS magnets for FCC-type machines and muon colliders (Kashikhin, Zlobin)
  - HTS Undulators (Boffo)
  - Technology development for high-field SC magnets: performance improvement and cost reduction (Stoynev, Baldini, Krave)
- SRF Cavity LOIs
  - SRF R&D for future HEP accelerators (TBD)
  - SRF R&D for cosmic searches (Romanenko)
  - DarkSRF experiment (Romanenko)
  - US-based e+e- SRF linear collider with costs based on LCLS-II (Grassellino)

## Accelerator Science (2)

- Accelerator Support LOIs
  - Cryogenics (Theilacker)
- Targets LOIs
  - Increase proton irradiation and PIE capability at Fermilab to support future multi-MW target development; Novel material development; remote handling and robotics development (Pellemoine, Zwaska)
- Beam Dynamics LOIs
  - Several LOIs are under discussion, input needed from the community's HEP LOIs first (TBD)

# Outlook

Fermilab scientists are positioned to make significant contributions to the 2021 Snowmass process

The SAC working groups are providing a framework for discussions and collaborations between Fermilab scientific staff on Snowmass topics (often cross-division/department)

Fermilab scientists intend to continue to work with the HEP community to develop a high-impact, well-developed plan that will lead to another vibrant Snowmass-P5 cycle in the early 2020s

# Backup

# What is the SAC?

- Diverse scientific expertise
- Founded in 2013, group of 16 scientists with diverse expertise
- Meet ~weekly with members of directorate to discuss matters of relevance to staff, including short- and long-term scientific planning
- Ongoing activity regarding Snowmass planning



## Continuing through Oct 2020:

[Karie Badgley](#) (APS-TD / Muon)  
Daniel Elvira (SCD / CMS)  
Zoltan Gecse (PPD / CMS)  
Brendan Kiburg (PPD / Muon, co-chair)  
[Petra Merkel](#) (PPD / CMS)  
Diktys Stratakis (AD / Muon)  
Louise Suter (ND / NuMI, past-chair)  
[Matt Touns](#) (ND / MicroBooNE)

## New Members ( Oct 2019 to Oct 2021):

Robert Ainsworth (AD / MI)  
Stefan Hoche (PPD / Theory)  
Jeremiah Holzbauer (PIP-II Division / PIP-II)  
Bo Jayatilaka (SCD / CMS, co-chair)  
Gordan Krnjaic (PPD / Astro Theory)  
[Anne Schukraft](#) (ND / SBN)  
Andrew Sonnenschein (PPD / Astro)  
Tiziana Spina (APS-TD / Magnets)

# Fermilab Scientific Advisory Council (SAC) Charter

The Scientist Advisory Council is a group of approximately 15 members of the Fermilab scientific staff. The composition of the group is diverse in areas of expertise and experience. Terms are for a two-year period, with half of the group rotating out each year. At the beginning of September each year, the laboratory director solicits nominations via the “all-scientists” distribution list. The demographics being sought will be announced (i.e. number from each organizational unit). Self-nominations are accepted. Following the open nomination period, new council members are selected by the current council in consultation with the director. New terms begin October 1.

The council will meet regularly (approximately weekly) with the director. The charge to the council is to engage in open discussion on topics of interest for both short- and long-term plans for the laboratory’s research program. The council will also discuss issues related to careers and professional development of the Fermilab scientific staff.

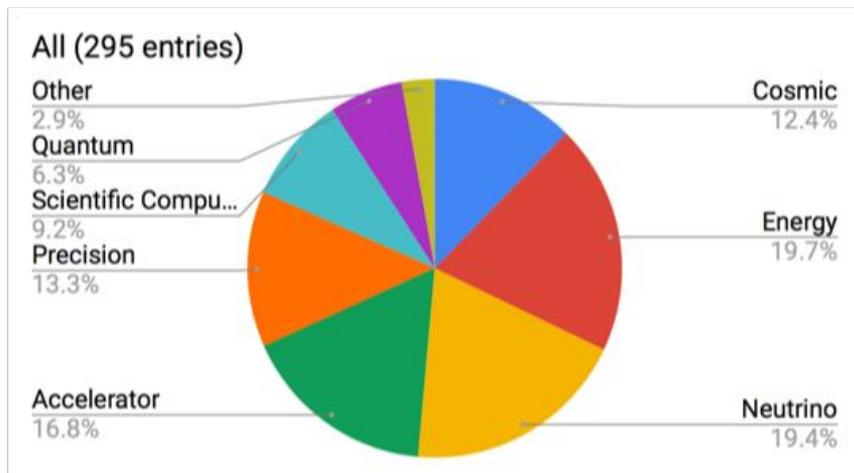
Members of the council are encouraged to share the discussion topics within their respective organizations to gather feedback and input from the broader scientific staff that the council can then share with the director. On occasion, the outcome of discussions may lead to the council initiating a sub-committee study of a theme or convening an all-scientist retreat to engage broader discussion of the topic.

*Last updated August 29, 2014*

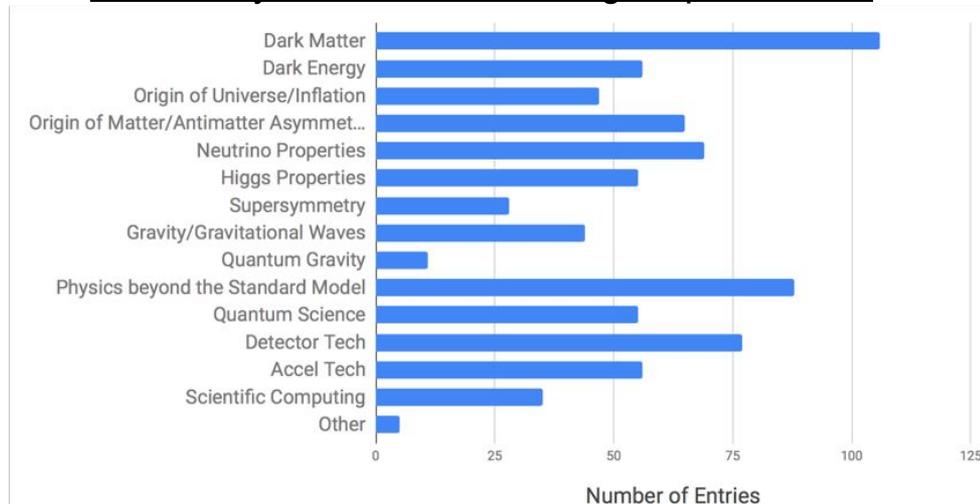
[From the SAC public webpage](#)

# Example 2019 Poll Result

## What do you work on?



## What are you excited to investigate post-2026?



- Poll represents a “snapshot” of the staff when administered. Retreat itself generated enough discussion that likely some results would change if administered again today. Results reflect current knowledge of scientific staff and highlight importance of making sure people are well informed.
- Poll very helpful in generating discussions both in and across working group boundaries and has helped to focus discussion on topics of highest interest.